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MOBILE LABORATORY: DEVELOPMENTAL AND REAL WORLD APPLICATION ASPECTS

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The Trace Organics Section of Laboratory Services Branch, Ontario Ministry of the Environment has developed a mobile laboratory to provide on-site qualitative and quantitative target volatile organic compounds analysis and rapid classification and/or identification of unknown hazardous wastes. State-of-the-art instrumentation such as capillary gas chromatograph, GC/MS, and Fourier Transform Infrared Spectrophotometer have been integrated into the mobile unit over the past three years. We present in this report, established criteria for effective equipment implementation and operation of the mobile laboratory. The examples for on-site surveys illustrate the versatility of such a unit in performing real-time sample analysis which would otherwise be difficult or impossible to achieve.

A mobile laboratory is useful for on-site analysis and remedial action of environmental problems, e.g. chemical spills, screening incoming organic/inorganic wastes at licensed disposal facilities and industrial effluents. Some of the advantages of the mobile laboratory include: rapid turnaround time - the time taken for the analytical result to reach the client; minimal sample handling and storage resulting in good sample integrity; classification and identification of unknown samples and establishment of client liaison which results in a clearer definition of the problem.

The success of a mobile laboratory depends upon its design, instrumentation, well defined analytical protocols, established quality control/quality assurance procedures and qualified staff.

DESIGN CONSIDERATIONS

The Trace Organics Section's mobile laboratory was designed to be versatile. Mandatory requirements include:

Power - The mobile laboratory is equipped with separate circuits for instrumentation and utilities. Each circuit is fed by either shoreline power or on-board generators.

Instrumentation Facilities - Shock mounted platforms are provided for instrumentation to combat vibration. Steel lined cylinder compartments house four compressed gas cylinders which terminate at four locations within the mobile laboratory, with double end shut-off quick connect fittings.

Fumehood - A 150 cfm stainless steel fumehood is located at the back of the mobile laboratory, externally exhausted.

Sample and Standard Storage - The mobile laboratory is equipped with a reffridgerator with separate compartments for standards and samples. Power can be AC/DC or propane.

INSTRUMENTATION

Instrumentation depends upon the nature of the investigation, e.g. organic or inorganic analysis, expected level and range of contamination and analysis of volatile or non volatile compounds. Instrumentation must be rugged, with a degree of simplicity. Vibrations during travel remain, despite shock mounting, therefore

adequate precautions must be taken to ensure instrument performance. A 'bounce test' is usually wise before equipment is accepted for use. Maintenance of equipment can be difficult in the field due to site location and lack of spare parts. This type of problem can be minimized by the instrumental design.

We have successfully operated the following instruments in the field:

1. Automated headspace analyser, coupled to a capillary gas chromatograph with an effluent split to a flame ionization detector and electron capture detector, fully computer controlled.
2. Automated headspace analyser, coupled to a capillary gas chromatography with a flame photometric detector, fully computer controlled.
3. A manual purge and trap analyser, coupled to a capillary gas chromatograph with a mass selective detector, fully computer controlled.
4. A Fourier transform infrared spectrophotometer, with a data station capable of a compound library search.
5. Various other instruments for the determination of flashpoint, pH and conductivity.

ANALYTICAL PROTOCOLS

The following protocol is followed for processing environmental samples of industrial waste, chemical spills, landfill leachate and citizen complaints in the field.

1. Preliminary Investigation consisting of (a) Manifest or Waste Classification, (b) Historical Data, and (c) Odour

2. Screening Techniques: (a) pH - industrial waste, (b) conductivity - groundwater, (c) flashpoint - flammable liquids, (d) FTIR Screening - classification of waste, (e) mass spectral search for non targeted volatiles, (f) non aqueous headspace screening, and (g) aqueous headspace dilution

3. Routine Analytical and Confirmational Techniques: (a) aqueous headspace for targeted volatiles, (b) soil headspace analysis for targeted volatiles, and (c) purge and trap/GC/MSD of targeted compounds. (See Appendix 1 for targeted volatile compound list)

The Ontario Ministry of the Environment mobile laboratory is equipped with state-of-the-art equipment to perform the above analyses. Complete protocol of the procedures can be found in the Ontario Ministry of the Environment methods.

QUALITY ASSURANCE / QUALITY CONTROL (QC/QA)

Mobile staff strictly follow Ontario Ministry of the Environment guidelines and protocols for QC/QA, some of which are given below:

1. Two calibrations per set of routine headspace runs (24 samples), one at the beginning and one at the end.
2. One blank per six samples.

3. Purge and Trap/MSD confirmation of targeted compounds identified by headspace/FID/ECD.

4. Random (same instrument) duplicate analysis of calibrations and samples for within run and between run (different instrument) precision.

5. Routine check for linearity with both standards and samples (multi-level calibration)

6. Use of surrogate standard (deuterated bromobenzene) for recovery check.

7. Random external laboratory (typically MOE) confirmation of results.

8. Daily control charting of all targeted compounds.

CASE STUDIES

Two case studies are presented in order to illustrate the effectiveness of mobile monitoring. They differ widely in approach and reflect a degree of versatility.

CASE 1: SURVEY OF PRIVATE WELLS IN A SMALL COMMUNITY FOR SUSPECTED PETROLEUM HYDROCARBON CONTAMINATION.

Information regarding the type and extent of contamination was desired to determine the possible source(s) of contamination and the remedial action needed. In a meeting prior to analysis, the history of the problem, and a map outlining odour complaints was furnished.

Over sixty residential wells were tested in a two week period. Analysis revealed that of twenty-three residences with a taste and

odour complaint, nineteen contained evidence of gasoline contamination. The benzene concentrations ranged from 5 ppb to 365 ppb. Pump-out tests, that is pumping of wells over time with interval sampling, indicated no appreciable decrease in concentration. A second pocket of tetrachloroethylene contamination affecting four residences was also discovered in an area that was historically the site of a tannery. Several potential sources of gasoline were identified.

Prior to this survey, carbon filtration units for each affected residence was being considered for remediation of the problem. This was based on routine laboratory analysis, performed prior to the mobile survey, which showed only two affected residences for the sixty-nine sampled. Remediation was later changed to a new drilled water supply and distribution system after the mobile survey.

CASE 2: ON-SITE ANALYSIS OF LIQUID INDUSTRIAL WASTE HAULERS AT AN INTERNATIONAL BORDER.

This was a joint effort between the Investigation and Enforcement Branch of the Ontario Ministry of the Environment and the Environmental Protection Agency of the United States.

Two mobile laboratories were requested for this survey to perform the following tests:

1. pH and flashpoint were used to determine classification of acidic, basic or flammable waste - typical turnaround time of <15 minutes.
2. Heavy metal and cyanide dip tests with treated paper to screen samples for further Laboratory Services Branch analysis of these parameters - typical turnaround time <15

minutes.

3. Fourier transform infrared spectroscopic analysis - used to screen samples for principle components in accordance with the manifest reported - typical turnaround time <20 minutes.
4. Headspace/capillary gas chromatograph/FID/ECD analysis - used to screen samples for volatiles, specifically chlorinated compounds.
5. Purge and Trap/capillary gas chromatograph/mass selective detector analysis - used for aqueous samples received, as another tool in conjunction with the headspace and FTIR analysis.

Over sixty legal samples were processed in three days, with strict adherence to legal protocol and continuity. In the majority of cases, manifest screening was completed before the safety inspection of the vehicle was complete.

FUTURE CONSIDERATIONS

The increasing demand for on-site analysis required for remedial action of environmental problems has resulted in progress to expand the capabilities of the mobile laboratory and meet the demands of the Ontario public. This expansion includes:

1. Increased target compound list for mass selective detection.
2. Use of retention indices as a more confirmational analytical protocol for headspace analysis.

3. Micro-sized solid phase extractions for PCB's and PAH's in aqueous and waste media.
4. Dynamic thermal stripping for MSD analysis for PCB's and PAH's in aqueous and solid media.
5. Dynamic headspace for quantitative analysis of volatiles in soil.
6. Instrumental evaluation of portable X-Ray fluorescence for identification of inorganic contamination.

APPENDIX 1

TARGETED VOLATILE COMPOUNDS

Trans-1,2-Dichloroethylene
1,1-Dichloroethane
Chloroform
1,1,1-Trichloroethane
Benzene
Carbon Tetrachloride
Bromodichloromethane
Trichloroethylene
1,2-Dichloropropane
Toluene
1,1,2-Trichloroethane
Tetrachloroethylene
Chlorodibromomethane
Chlorobenzene
Ethylbenzene
Bromoform
M/P-Xylene
O-Xylene
1,1,2,2-Tetrachloroethane
Naphthalene
1,4-Dichlorobenzene
1,3-Dichlorobenzene
1,2-Dichlorobenzene

Detection Limit is 2.0 ppb for headspace and 1.0 ppb for Purge and Trap

NON ROUTINE COMPOUNDS

Sulphur Compounds
Ketones, Acetates, Esters, Alcohols
Other Aromatics - di, tri and tetra methyl benzenes
Dowtherm - mixture of biphenyl, biphenyl oxides and methyl biphenyls



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